



# US LHC ACCELERATOR PROJECT

*brookhaven - fermilab - berkeley*

LHC Interaction Region Quadrupole  
CERN - Fermilab - KEK Collaboration Meeting

Fermilab

April 21-23, 1999

```
ANSYS 5.1
...
SUB = 1
TIME = 1
TEMP:
TEMP = 97.319
SMB = 1.8
SMX = 360
1.8
34.933
68.067
101.2
134.933
167.467
200.6
233.733
265.867
308
```

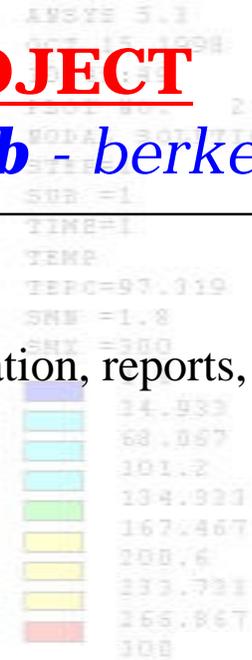


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## IRQ cryostat topics

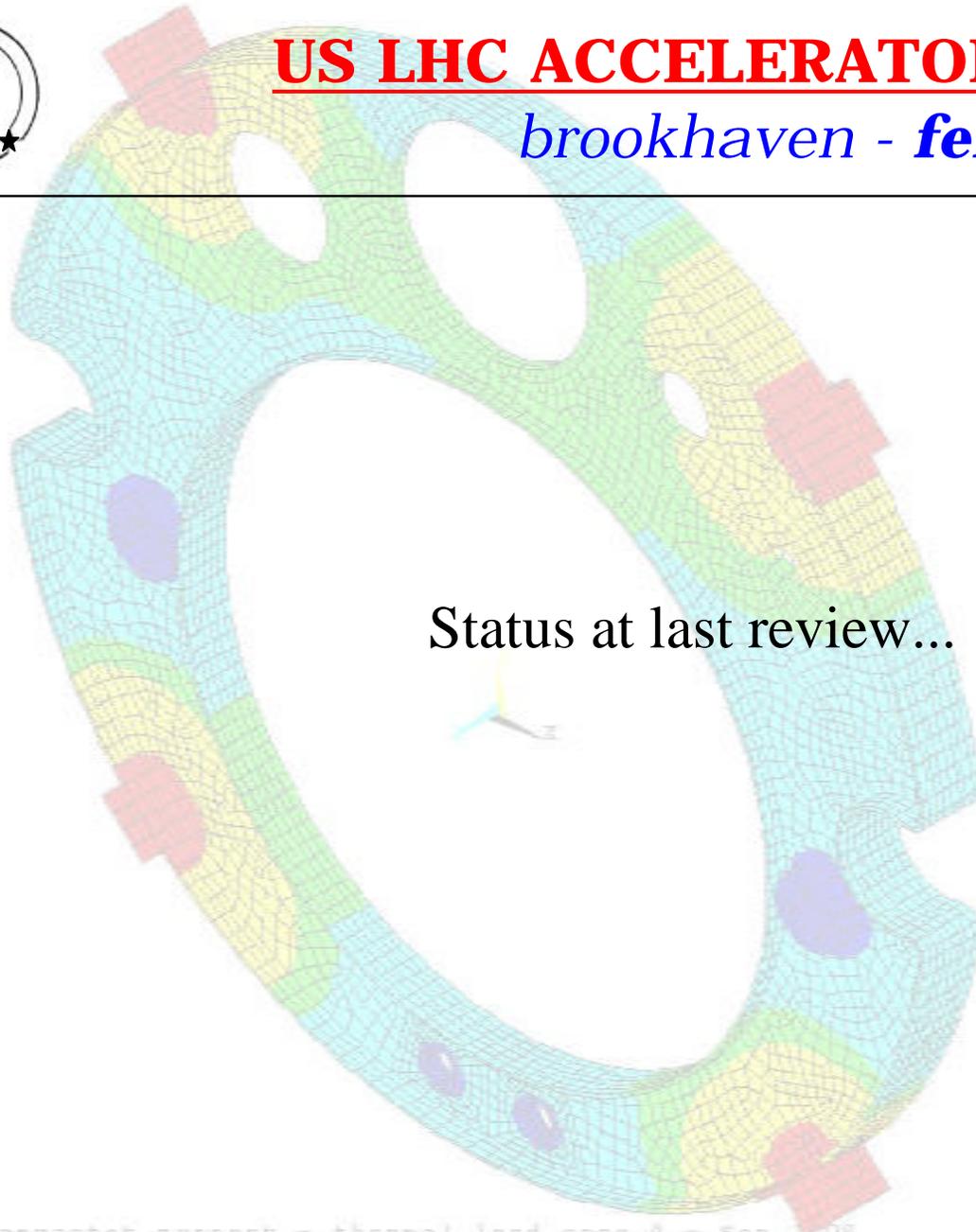
- For the current status on cryostat related activities, design information, reports, etc. visit: [http://tdpc02.fnal.gov/nicol/lhc\\_irq\\_cryostat/index.html](http://tdpc02.fnal.gov/nicol/lhc_irq_cryostat/index.html)
- Brief review of the status at the cryostat CDR (Dec 1998).
- Suspension system heat load update.
- Cold mass to suspension system interface.
- Cold mass to piping system interface.
- Final assembly concept.
- Cold mass configurations.
- Preliminary Q1 cryostat design concept.
- Concerns.
- (Several topics relating to the ongoing heat exchanger test facility will be addressed in separate sessions.)





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Status at last review...

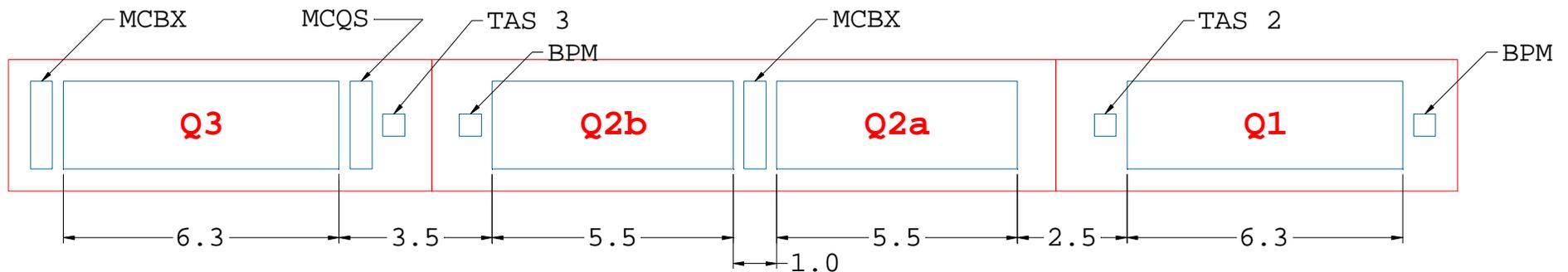
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1.8  
34.933  
68.867  
101.2  
134.933  
167.467  
200.6  
233.733  
265.867  
300
```



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## Triplet layout from optics



### Notes:

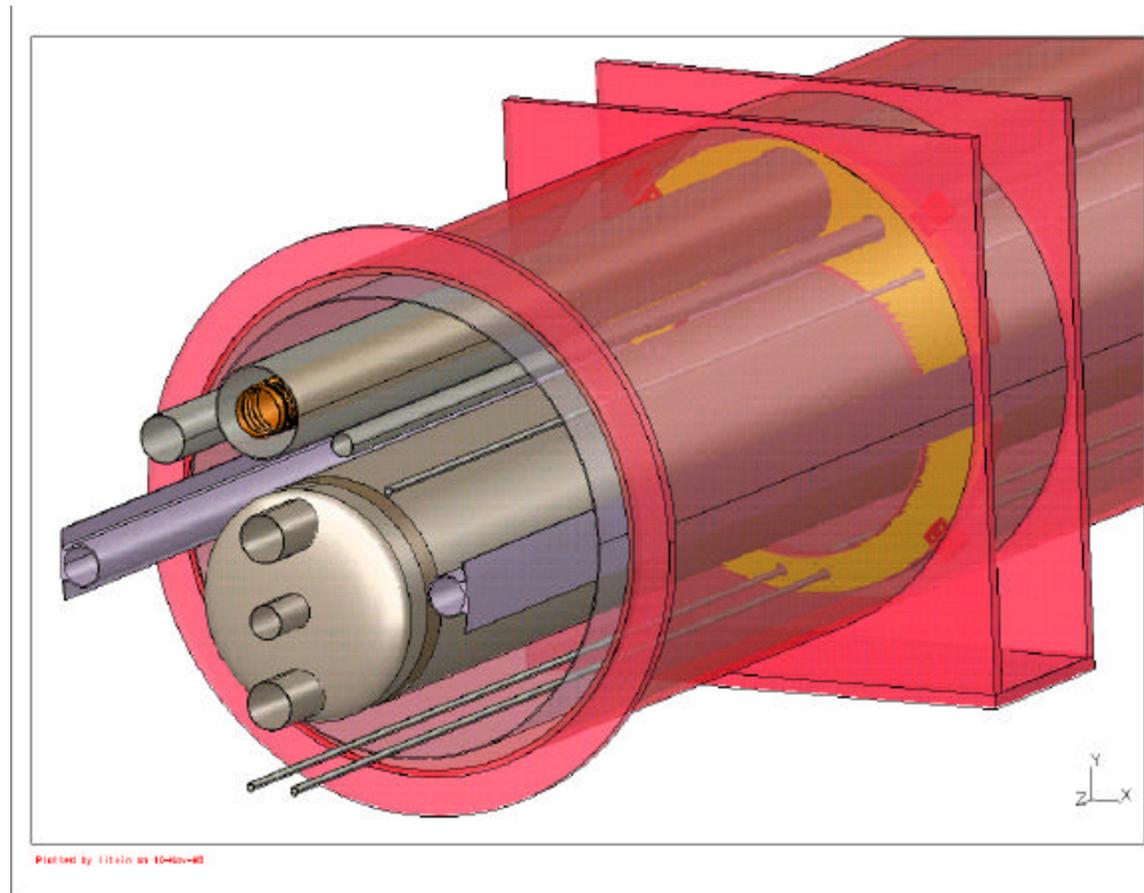
1. Optics are V6.1.
2. All dimensions are in meters.
3. Magnets are shown in magnetic length.
4. From Fred - 6.3 m magnetic length becomes 6.604 m end plate to end plate.  
5.5 m magnetic length becomes 5.804 m end plate to end plate.



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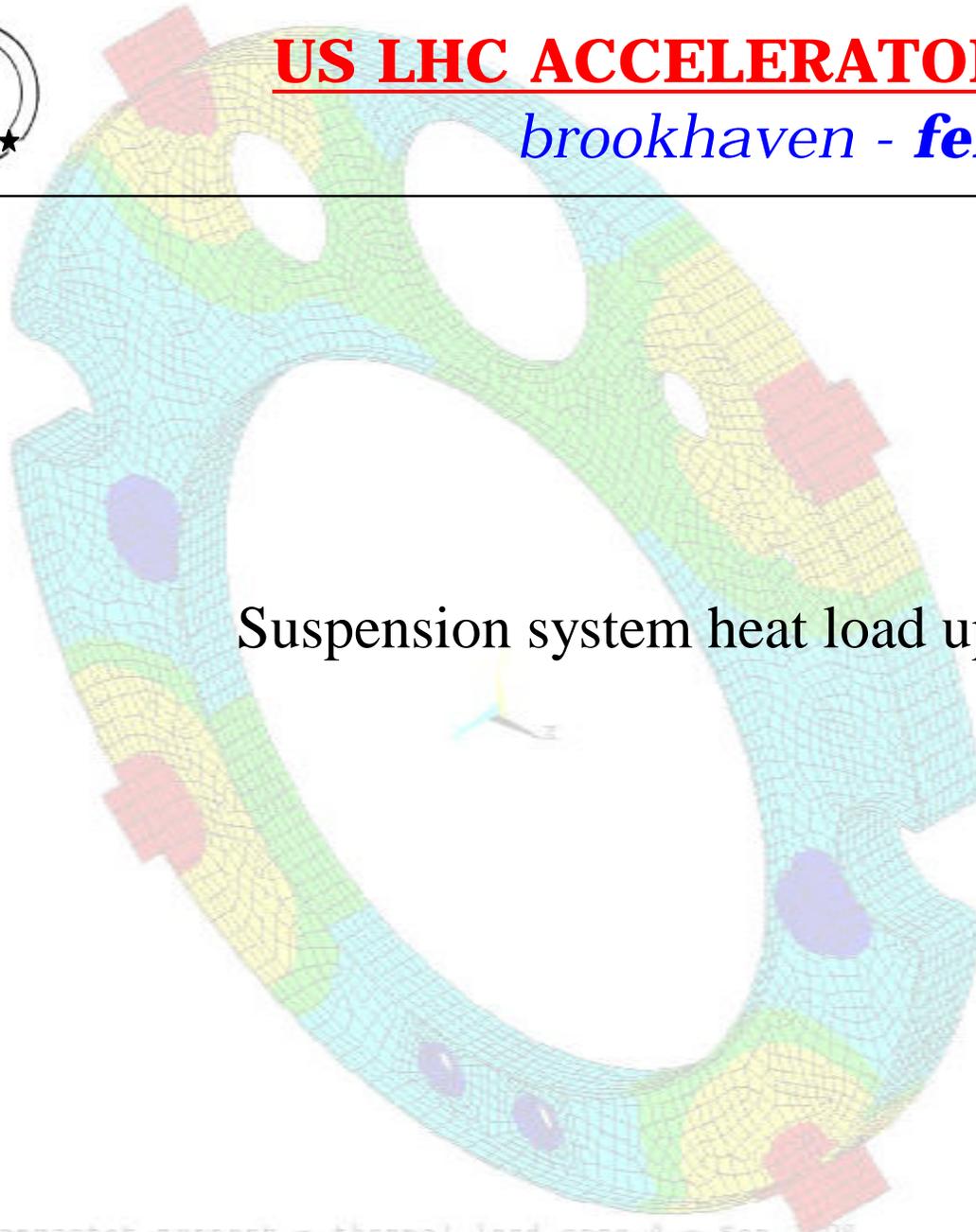
IRQ cryostat end view





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Suspension system heat load update...

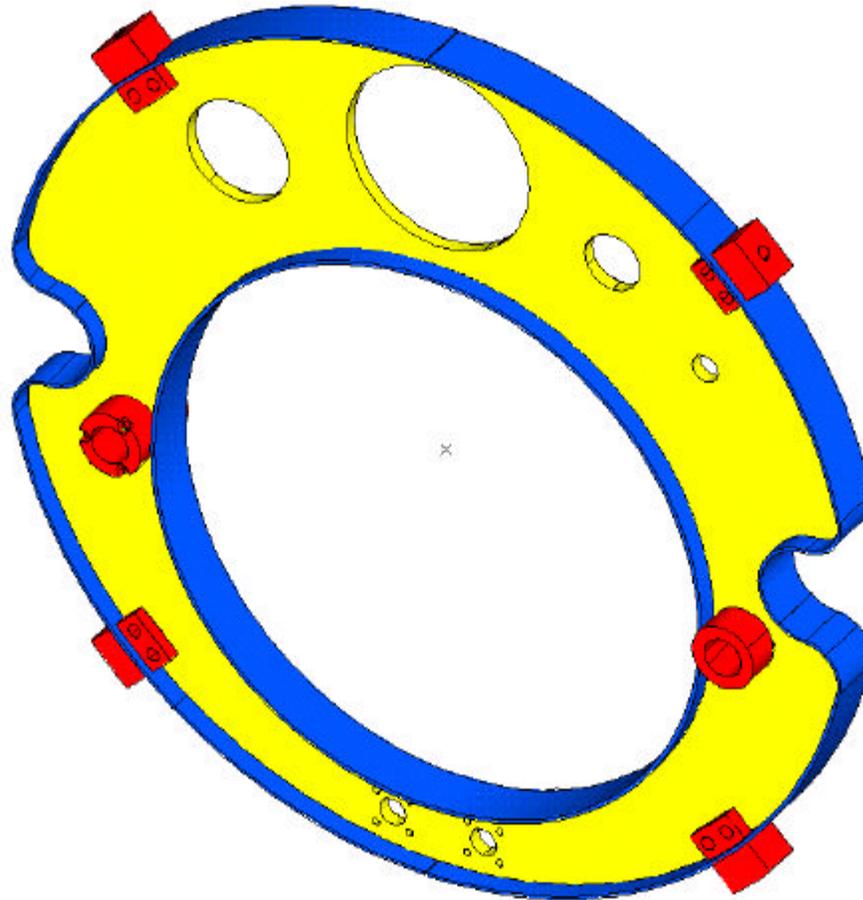
```
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SMX = 360  
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34.933  
68.867  
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200.6  
233.733  
265.867  
308
```



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## IRQ cryostat “spider” support

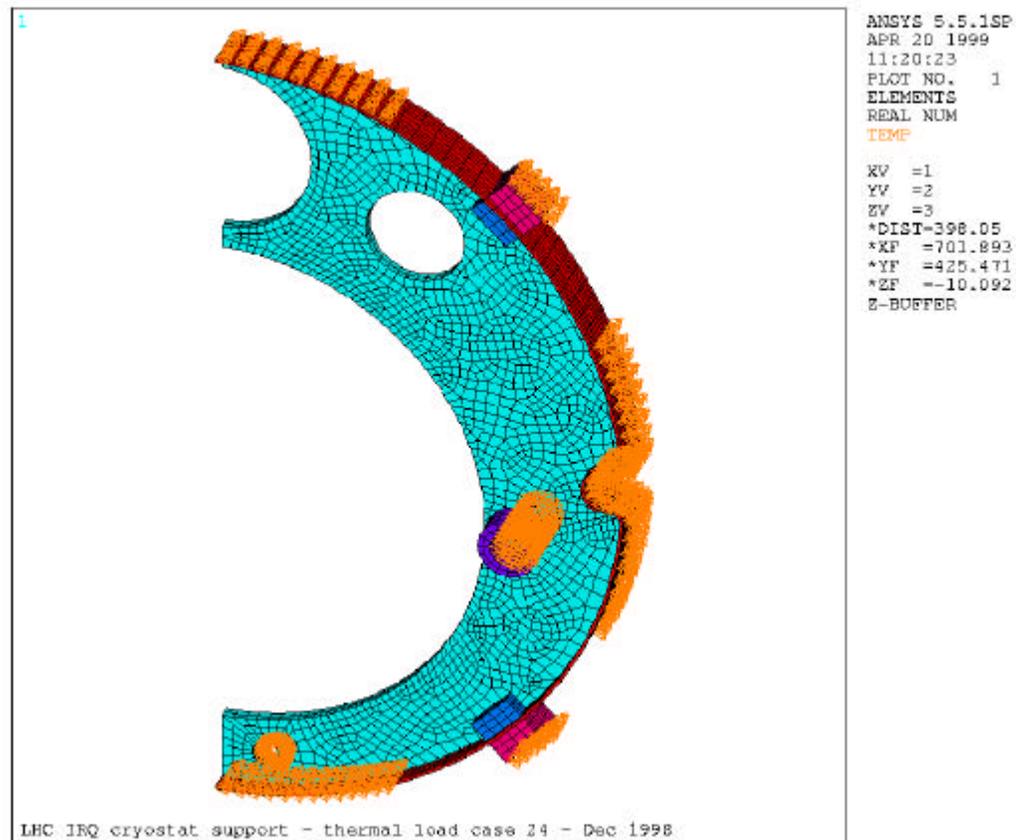




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## IRQ cryostat support analysis thermal boundary conditions

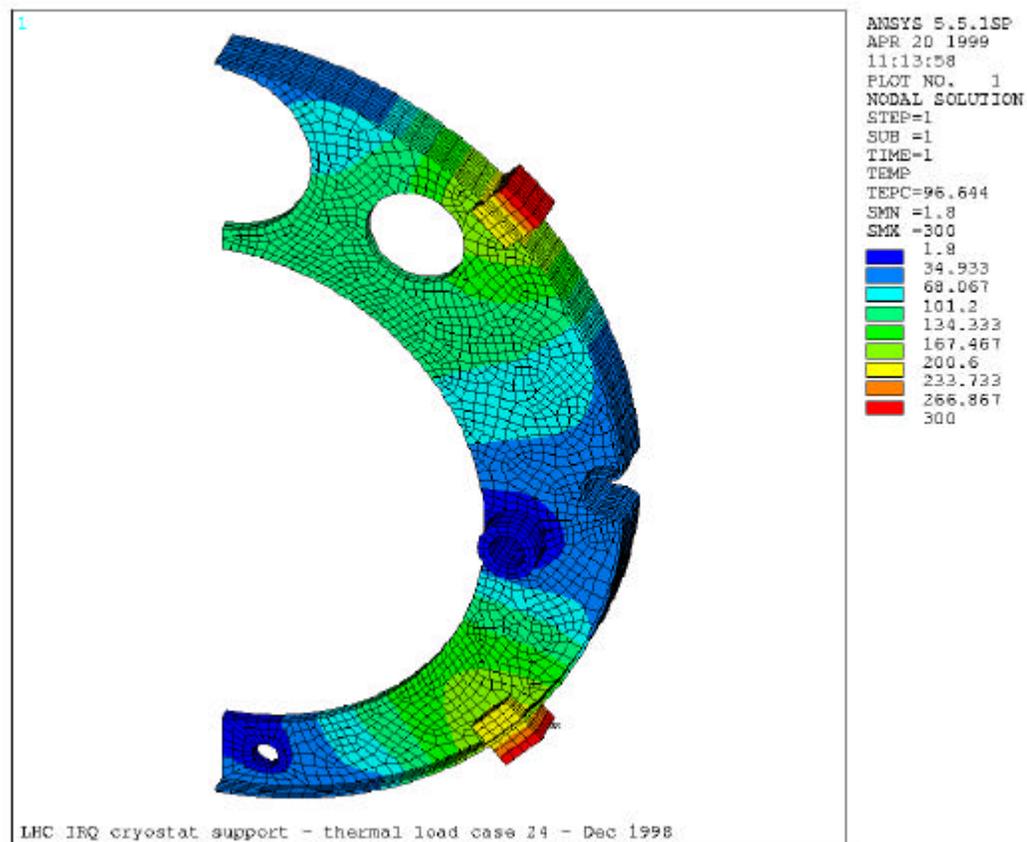




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## IRQ cryostat support analysis temperature distribution





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## Thermal design criteria and current heat load estimates

### LHC Interaction Region Quadrupole Cryostat Static and Dynamic Heat Load Summary

T. Nicol - January 1999

#### Inner triplet heat loads from ICEC paper (summer 1998)

Temperature level	50 to 75 K	4.6K	1.9K	Current lead flow
Static heat loads (W)	250	22	10	
Dynamic heat loads (W)	0	21	162	
<b>Total heat loads (W)</b>	<b>250</b>	<b>43</b>	<b>172</b>	<b>3.7 (g/s)</b>

#### Inner triplet heat loads - calculated

Temperature level	50 to 75 K	4.6K	1.9K	Notes
Static heat loads (W)	210	10	18	1,2,3
Dynamic heat loads (W)				
<b>Total heat loads (W)</b>	<b>210</b>	<b>10</b>	<b>18</b>	

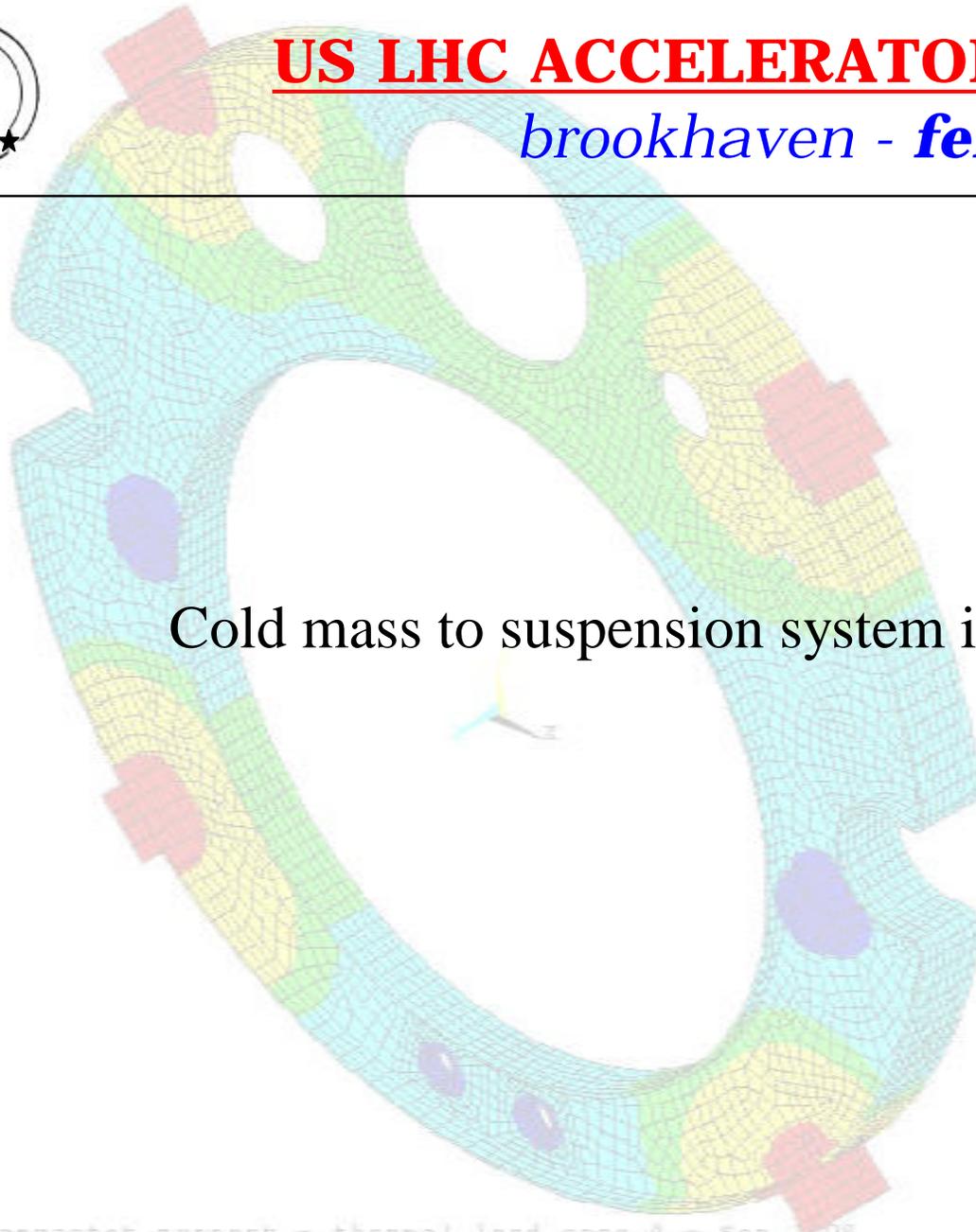
#### Notes

1. Static heat load to outer shield = 130 W conduction through supports + 80 W radiation and residual gas conduction.
2. Static heat load estimate to 4.5K is from support analysis only.
3. Static heat load to 1.9K = 12 W conduction through supports + 6 W radiation. Radiation estimate assumes  $\epsilon=0.1$ .



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```
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POST1  
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TEMP  
TEMP = 97.319  
SMB = 1.8  
SMX = 360  
1.8  
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68.867  
101.2  
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200.6  
233.733  
265.867  
308
```

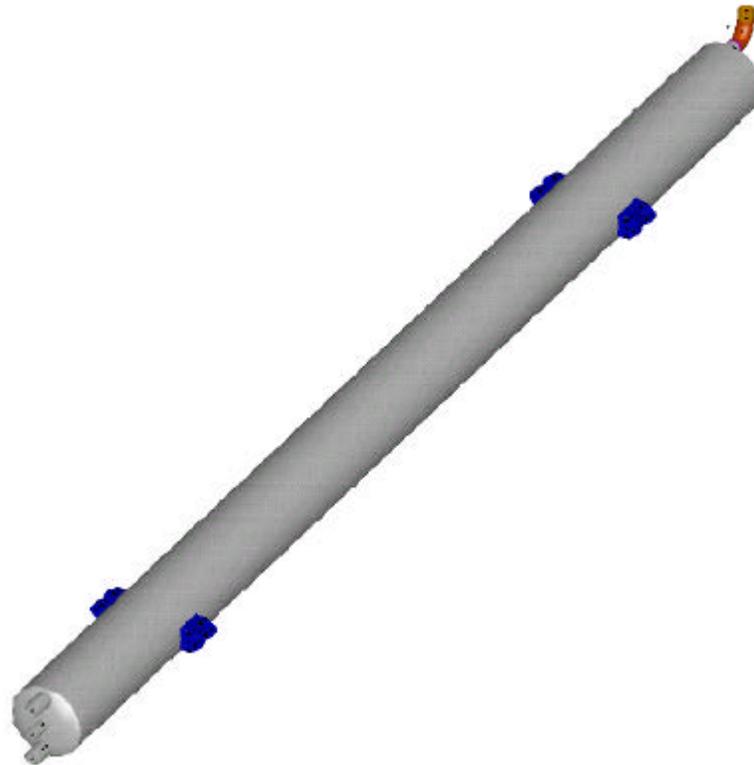
Cold mass to suspension system interface...



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Support to cold mass connection

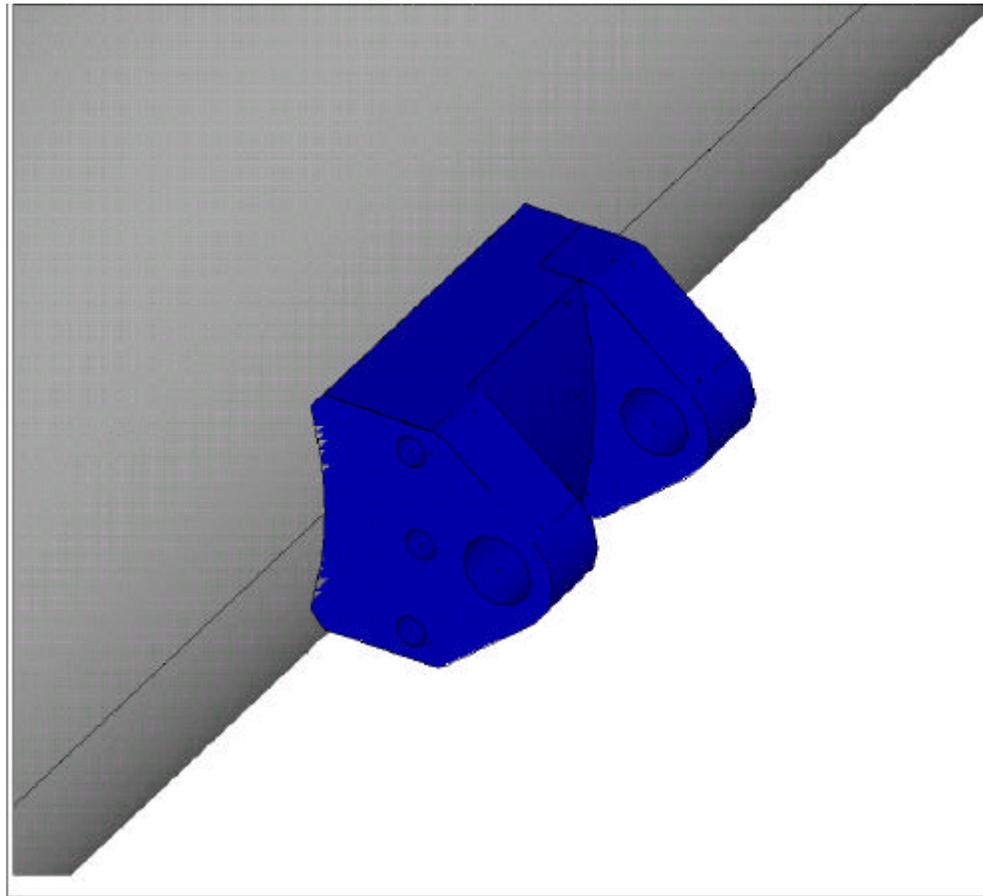




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Support to cold mass connection

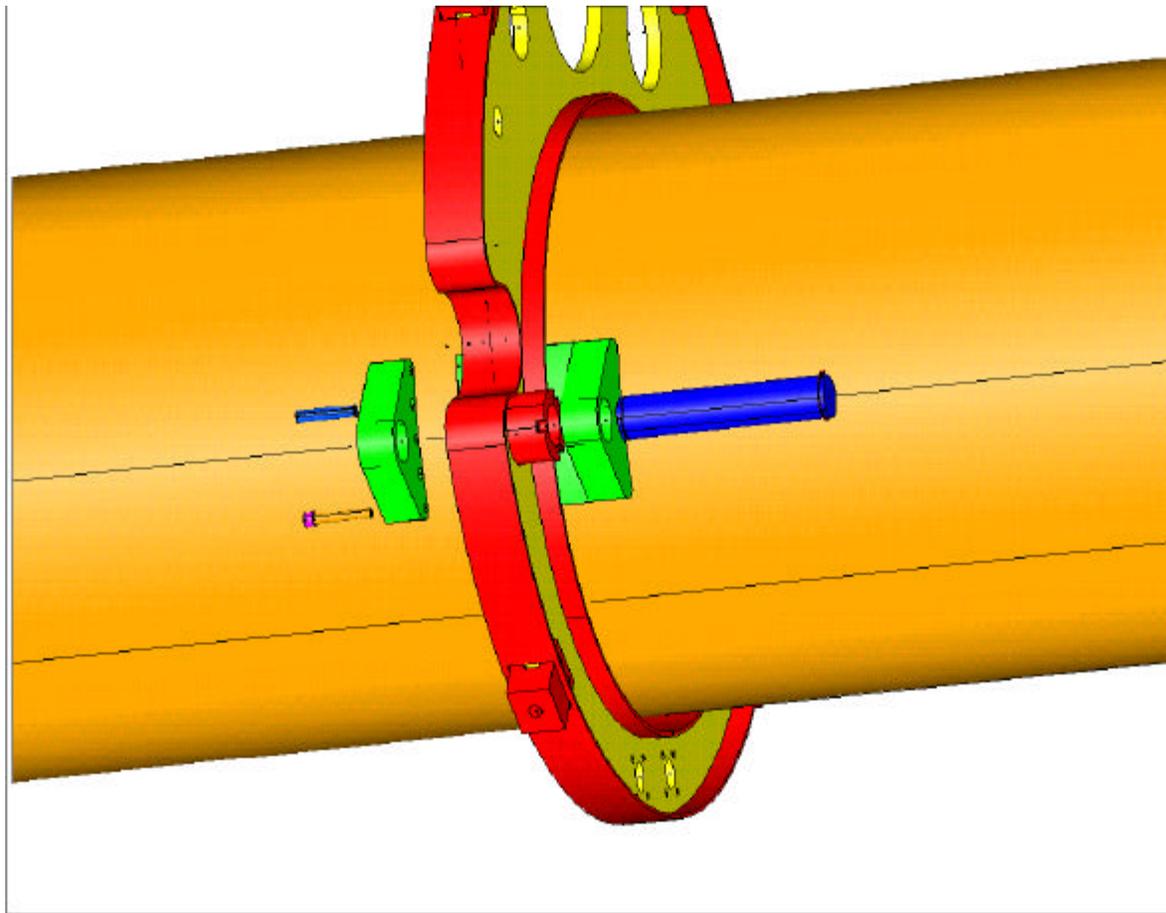




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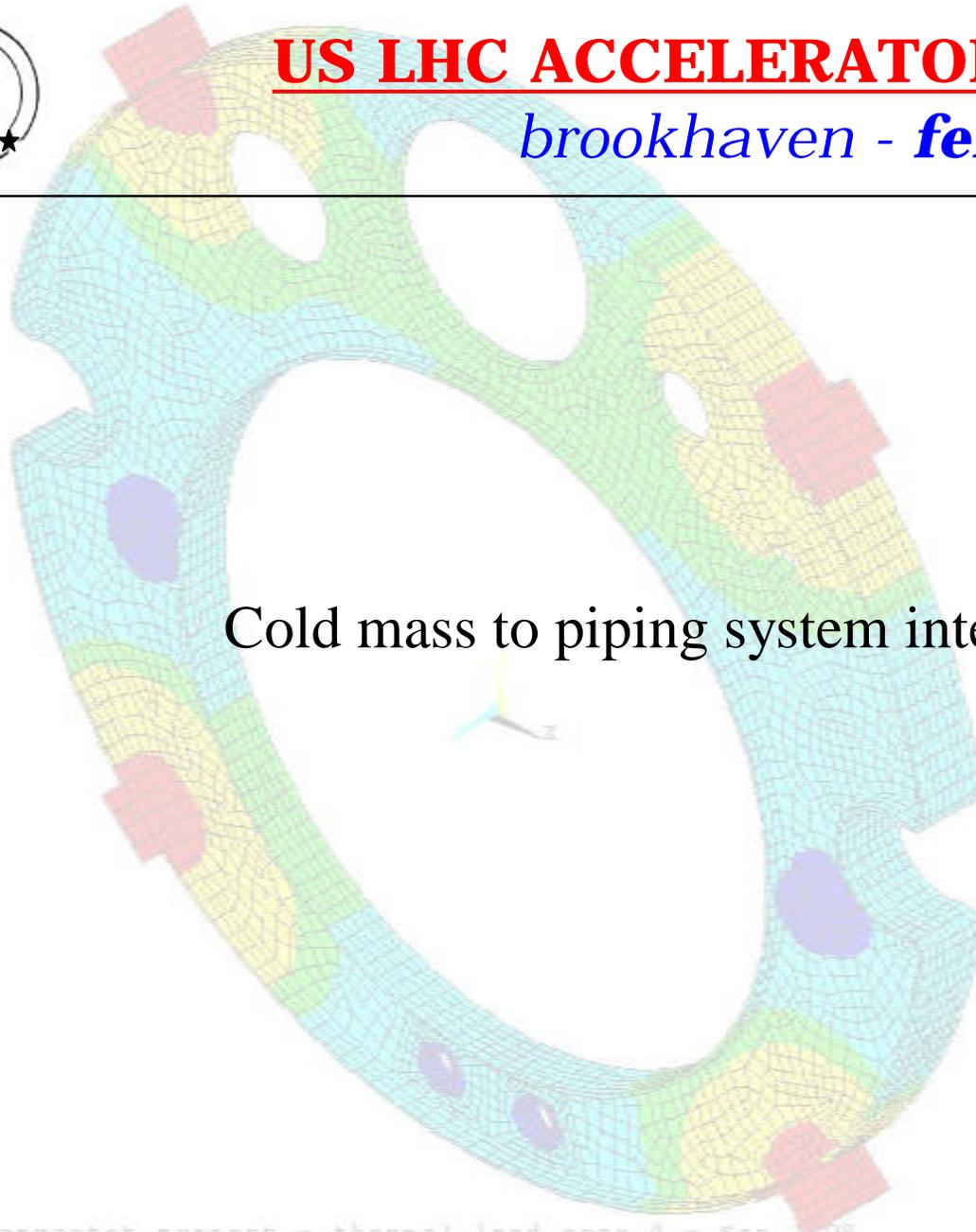
## Support to cold mass connection





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Cold mass to piping system interface...

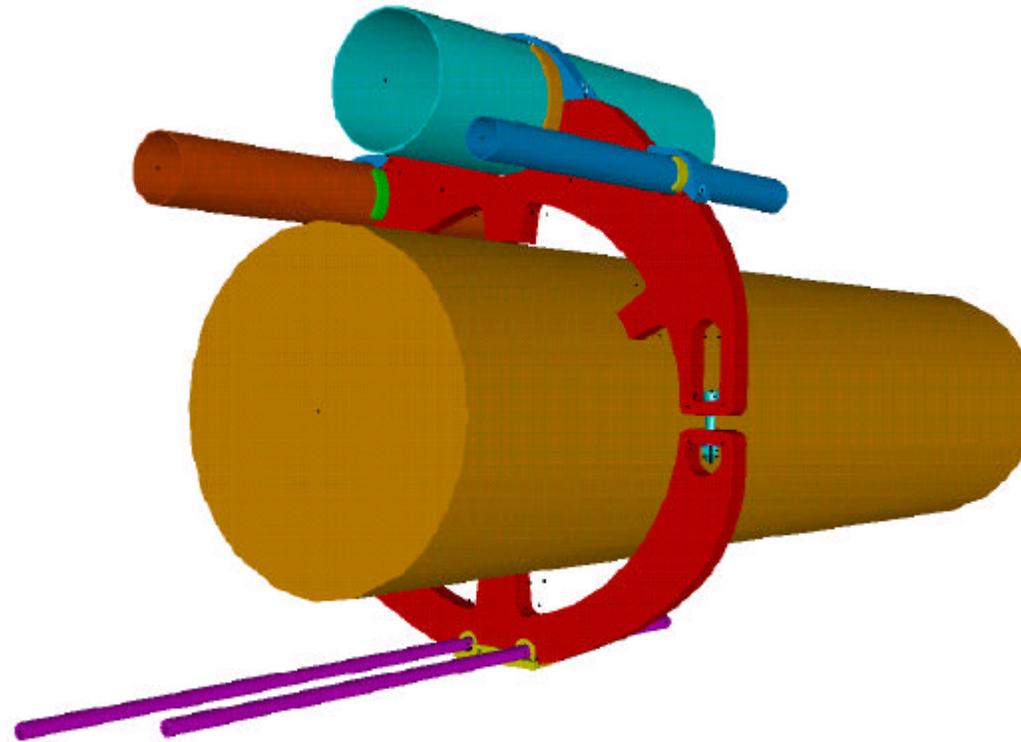
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SMX = 360  
1.8  
34.933  
68.867  
101.2  
134.933  
167.467  
200.6  
233.733  
265.867  
308
```



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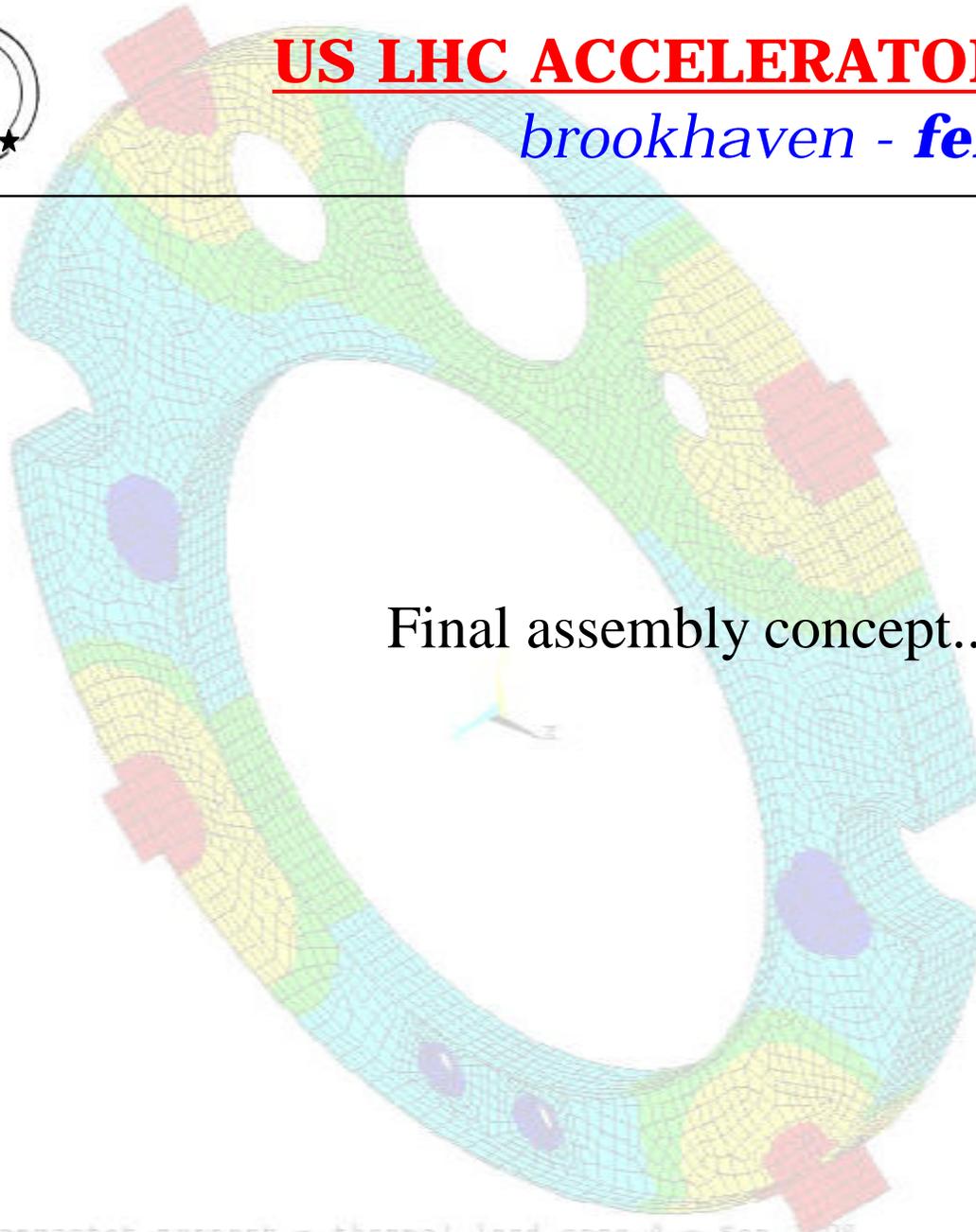
## Piping support design concept





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Final assembly concept...

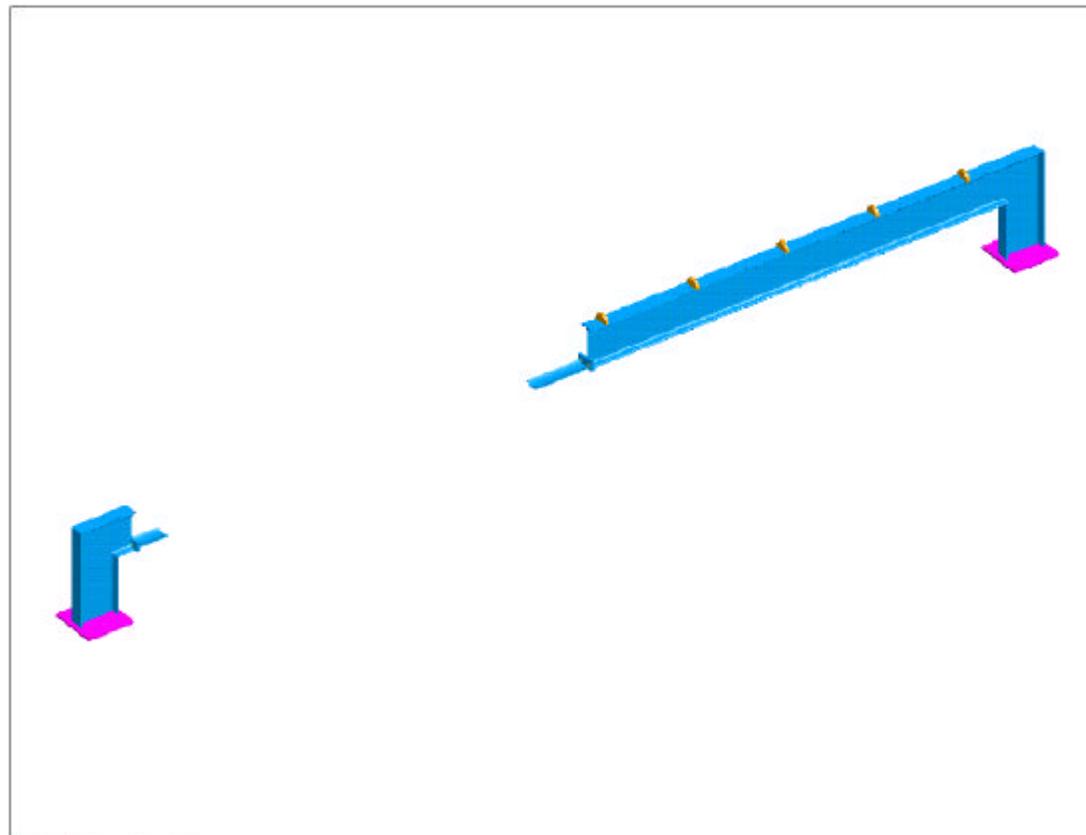
```
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SMB = 1.8  
SMX = 300  
1.8  
34.933  
68.867  
101.2  
134.933  
167.467  
200.6  
233.733  
265.867  
300
```



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## Assembly tooling insertion beam



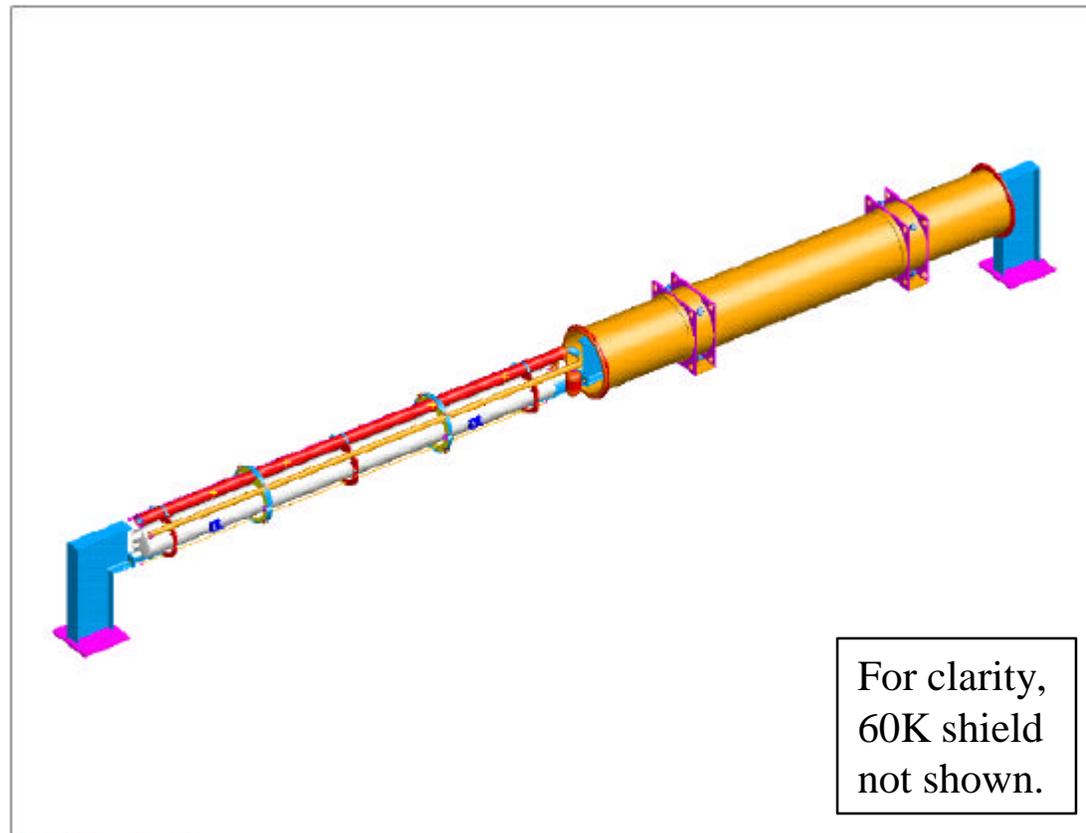
Printed by a3000 at 20-nov-1999



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## Assembly tooling insertion beam - initial setup



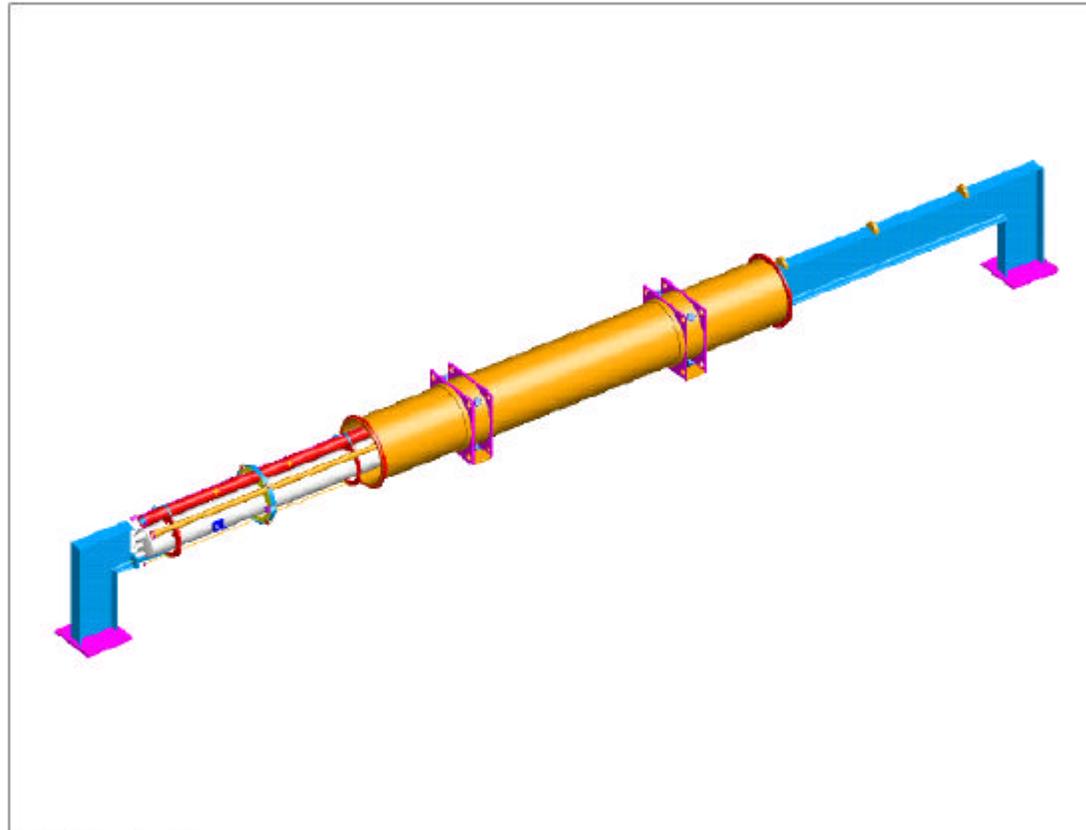
Plotted by a30016 on 20-nov-1999



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Assembly tooling insertion beam - insertion in progress



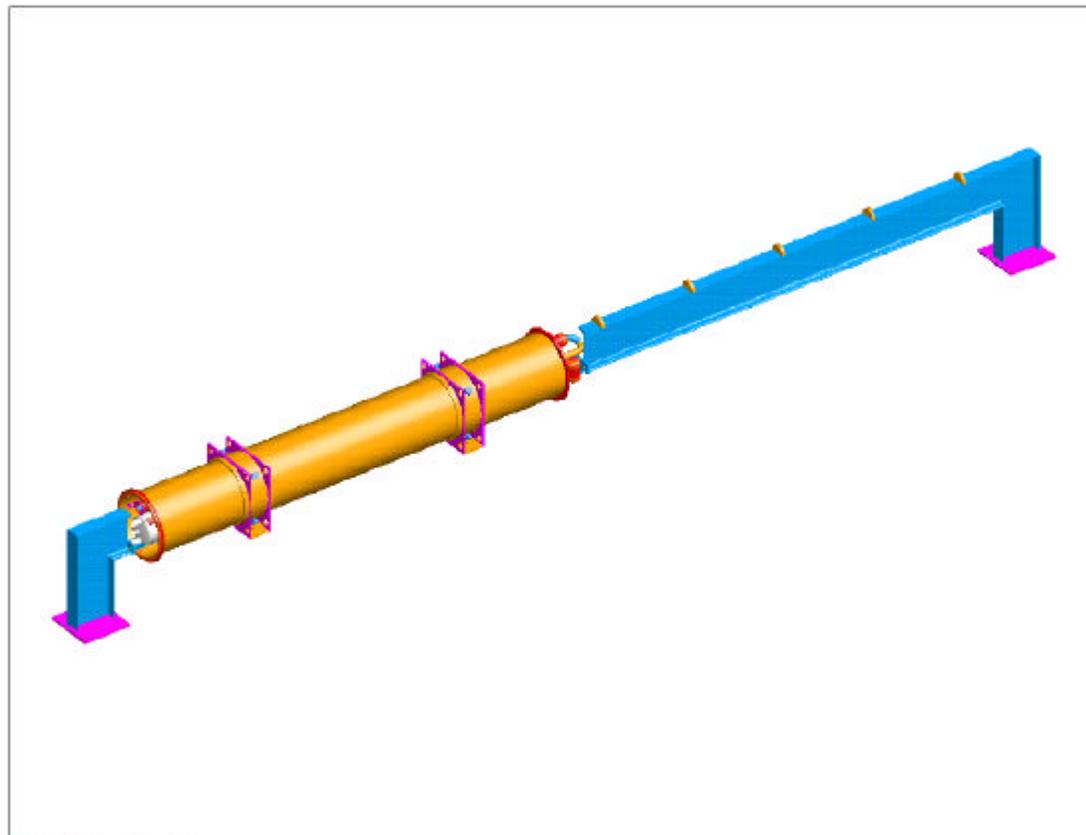
Plotted by a30016 on 20-nov-1999



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Assembly tooling insertion beam - insertion complete

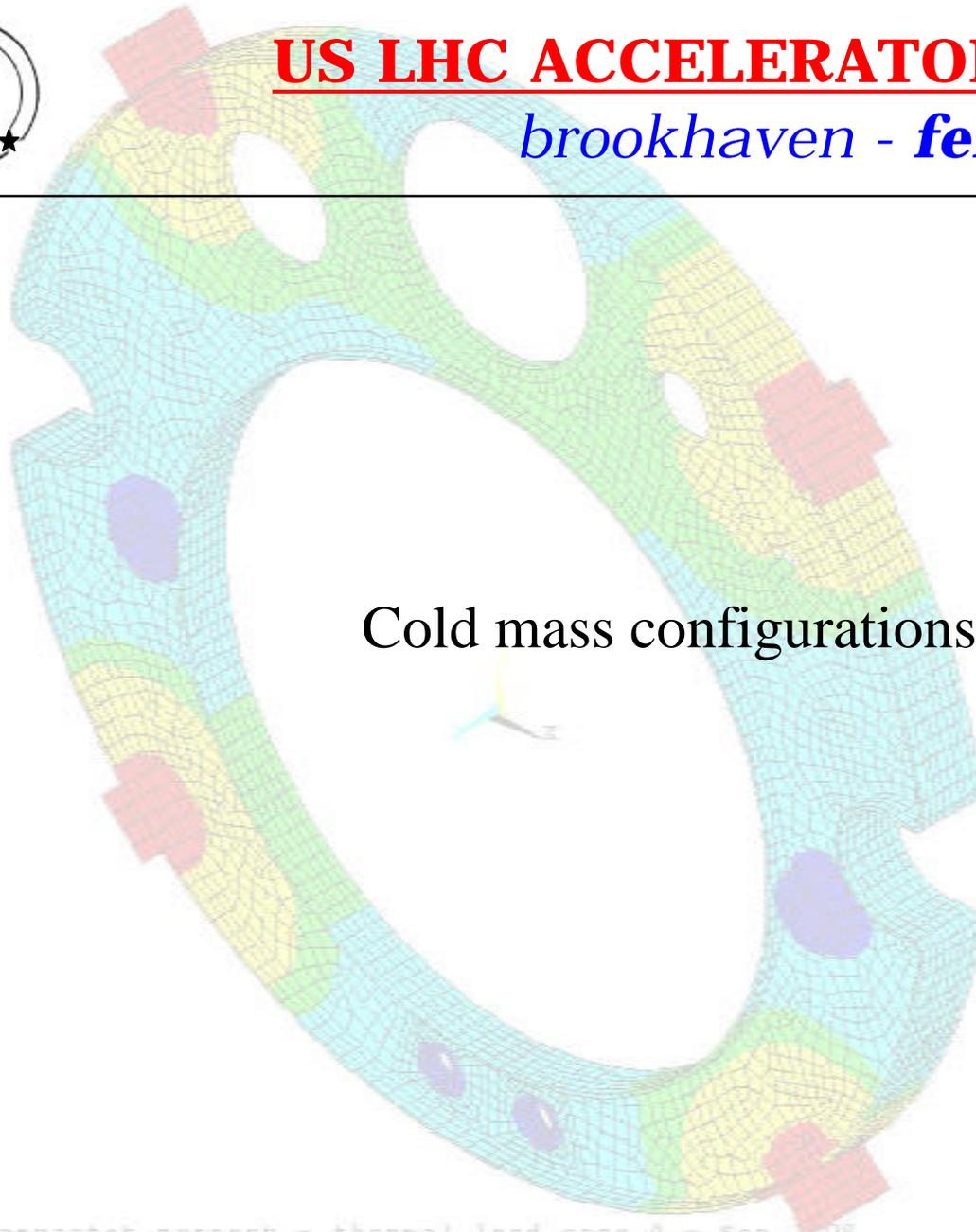


Printed by ssmk on 20-01-1999



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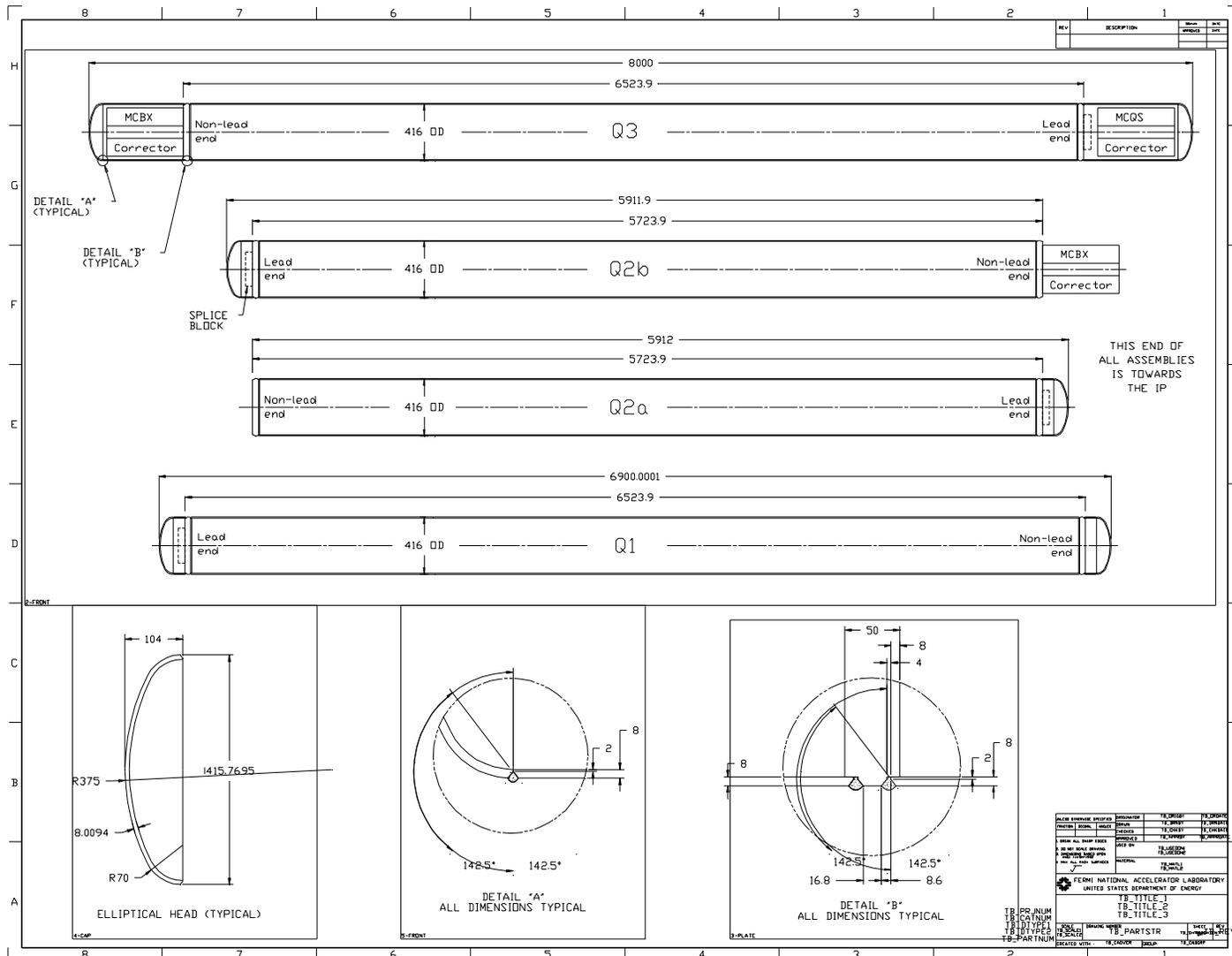
Cold mass configurations...

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34.933
68.867
101.2
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167.467
200.6
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265.867
308
```



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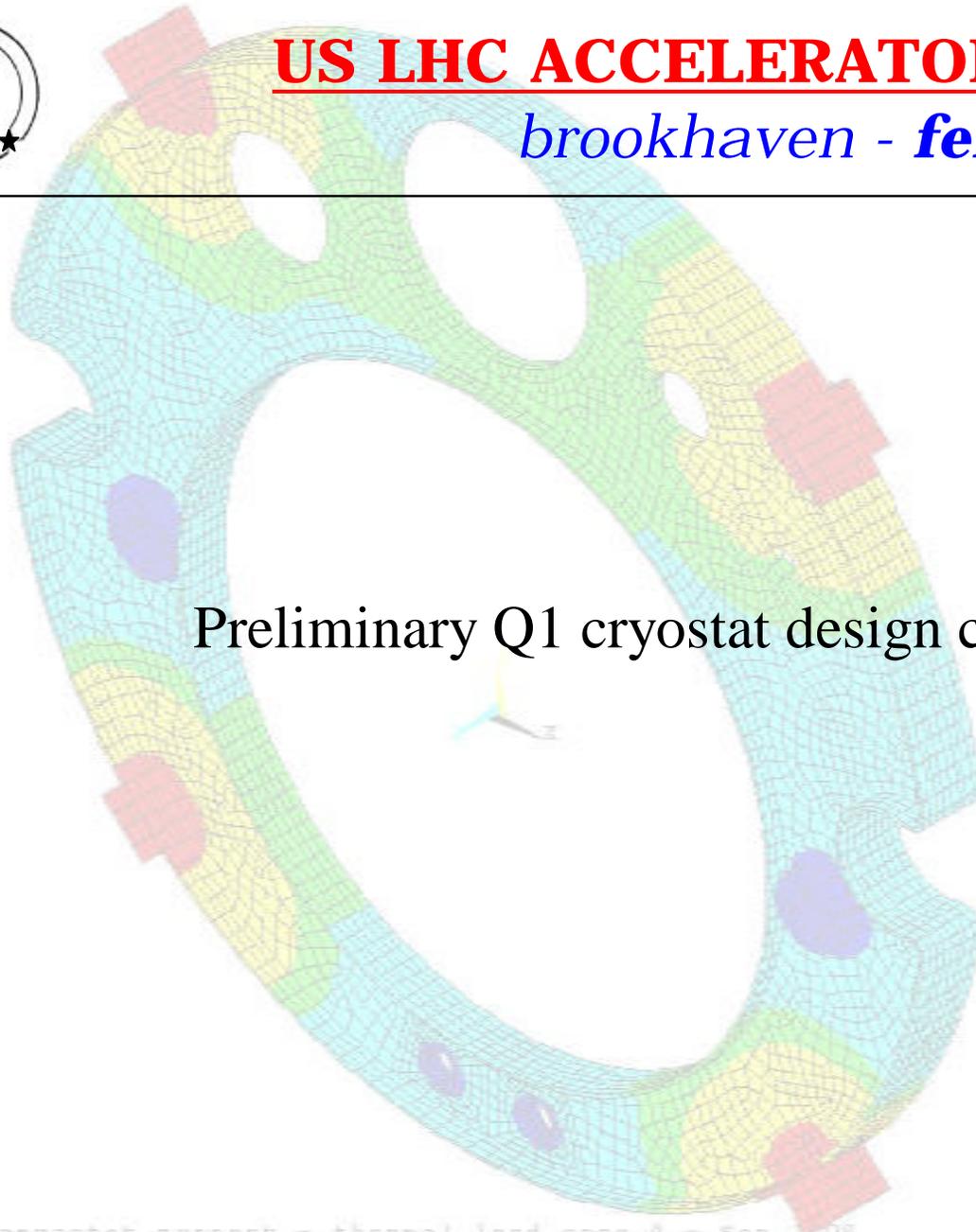






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Preliminary Q1 cryostat design concept...

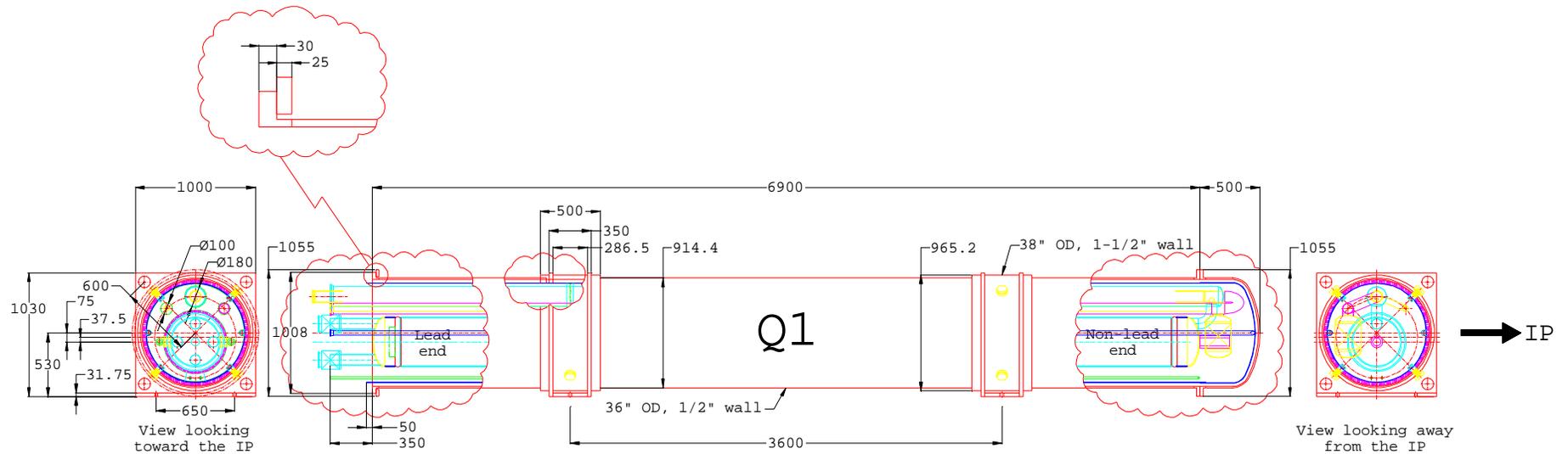
```
ANSYS 5.1  
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1.8  
34.933  
68.867  
101.2  
134.933  
167.467  
200.6  
233.733  
265.867  
308
```



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## Current Q1 cryostat conceptual design

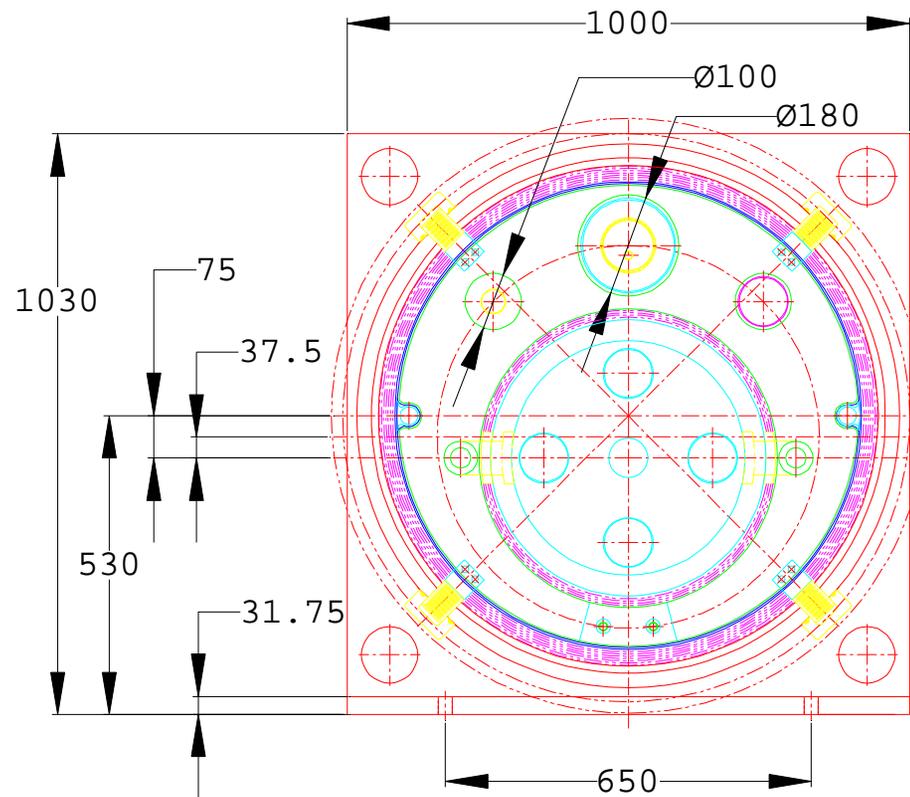




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## Current Q1 cryostat conceptual design



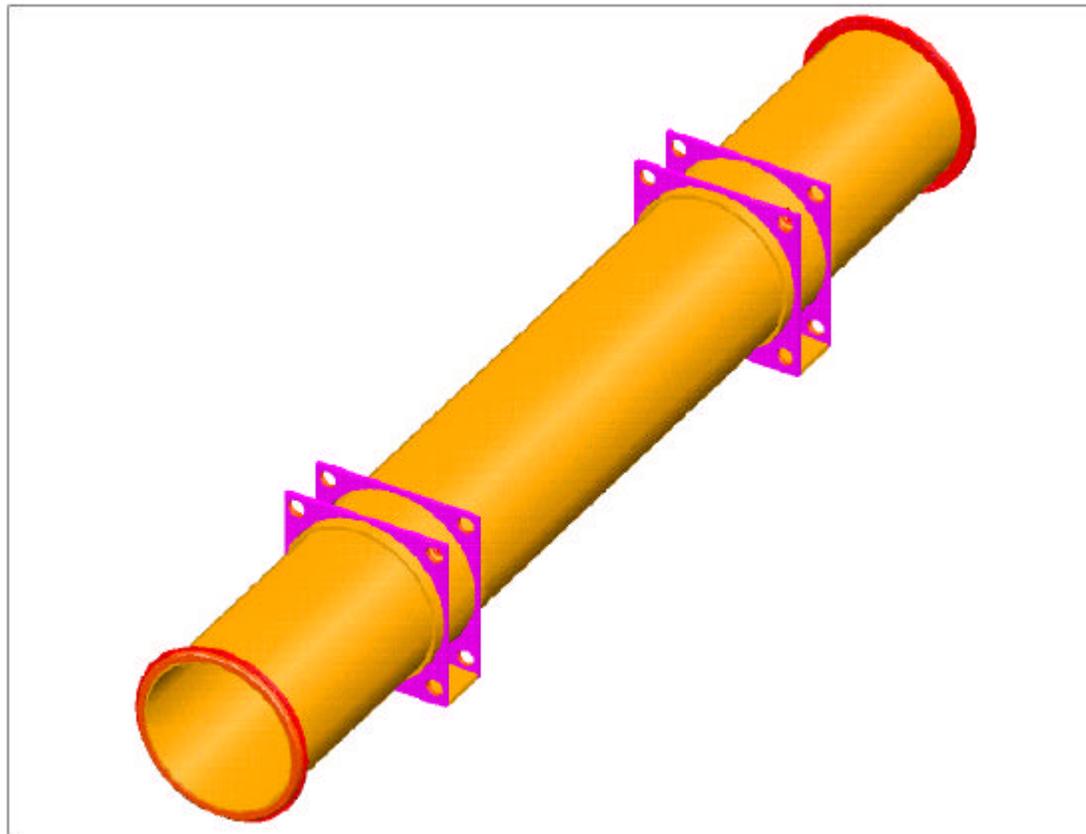
View looking toward the IP



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## Q1 vacuum vessel

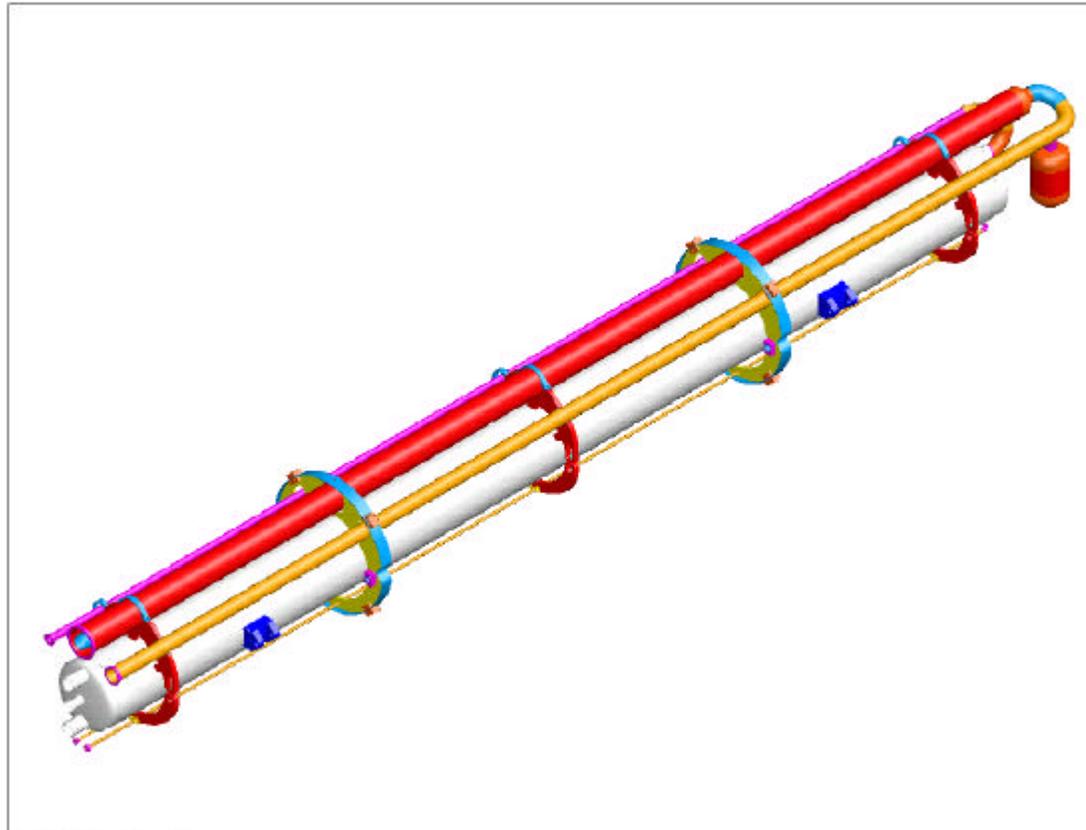




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## Q1 internal piping assembly



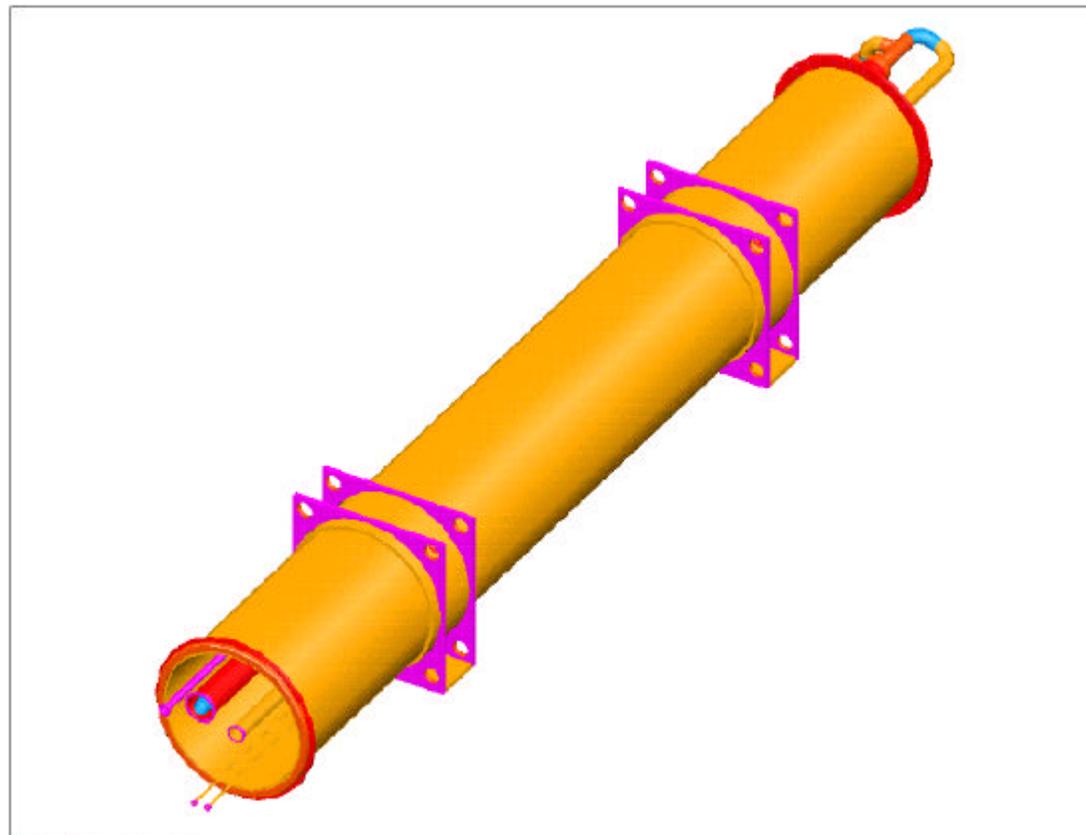
Plotted by ssmk on 20-nov-1999



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Q1 cryostat assembly (without end dome)



Plotted by a30016 on 01-Apr-1999



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## Concerns

- “Freezing” the design of non-Fermilab supplied interconnect components, especially BPMs, correctors, and beam tube details.
- Interconnection of the Q2a and Q2b.
- Coordination between Fermilab and KEK to standardize the cold mass mechanical and electrical connections and the end dome weld details.
- Availability of engineering resources for R&D (testing supports and support materials), design, and design qualification (e.g. shipping tests, etc.).

